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CEREAL LEAF BEETLE (COLEOPTERA: CHRYSOMELIDAE): INFLUENCE OF SEEDING RATE OF OATS ON POPULATIONS[1]

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ABSTRACT

In field and greenhouse studies, more cereal leaf beetle [*Oulema melanopus* (Linnaeus)] eggs and larvae were found per unit area on spring oats, *Avena sativa* L., planted either at intermediate (54 kg/ha) or high (136 kg/ha) seeding rates, than when planted at a lower seeding rate (14 kg/ha). However, there were fewer eggs and larvae per stem in plantings of the high or intermediate rates than in those of the lower rate. Oats should not be planted at less than the recommended rates in beetle-infested areas.

Since the detection of the cereal leaf beetle (CLB), *Oulema melanopus* (Linnaeus), in North America, a variety of pest management efforts have been made, including quarantine, chemical and biological control, plant resistance, and various cultural practices. One cultural practice that has been shown to reduce the population densities of other insect pests of small grains is seeding rate. For example, Luginbill and McNeal (1958) found that infestation and cutting of wheat by the wheat stem sawfly, *Cephus cinctus* Norton, decreased as the seeding rate increased and row spacing decreased. Apparently, the sawfly selected the larger, more succulent stems in the plots with fewer stems per unit area. Also, Agrios (1969) reported that better yields of barley were sometimes obtained despite the presence of barley yellow dwarf by increasing the number of plants per unit area through increased planting rates. When there were few aphid vectors, a greater number of plants escaped infection, but when the density of aphids was great, healthy plants could not be found in most fields, regardless of seeding rate. In parts of Russia, dense sowings in spring wheat nurseries are often used to reduce damage from a frit fly, *Oscinosoma pusilla* Meigen (Maistrenko, 1976).

Recommended rates, however, may not be used in planting for various reasons ranging from limited seed supplies to an improperly calibrated grain drill. Grafius (1956) and Woodward (1956) both found that in the absence of insects, diseases, or other stresses, wide variations in seeding rates of oats (around the optimum) produced only minor variations in yield. Woodward (1956) stated that on western irrigated land, farmers who planted at half the usual rate could afford to plant certified seed at no extra cost, and could thus reduce many farm problems associated with plant diseases and grain mixtures.

The present work is the initial phase of a long-term study to determine whether seeding rate can be used as a cultural practice in CLB management. In this work, we report the influence of three seeding rates of spring oats in small plots and in the greenhouse on CLB populations.

MATERIALS AND METHODS

Clintland 64 (C.I. 7639) oats were sown at rates of 14, 54, and 136 kg/ha [the recommended seeding rate in Michigan is 72-90 kg/ha (Hildebrand and Copeland, 1975)]

in 1970 and 1971. A 3 × 3 Latin square design with 6 × 6 m plots was used in 1970, while 9 × 27 m randomized strips with 1 strip/seeding rate were used in 1971. Plantings were made at two Michigan locations in 1970: Ingham County (1 May) and Kalamazoo County (5 May). In 1971, plots were sown in Kalamazoo County on 4 May.

In 1970, estimates of plant density were obtained by counting the number of stems collected on 19 June from 61 cm of row. In 1971, stem counts were made periodically, and also from 61 cm of row, but without removing the plant material from the field.

In 1970, one estimate of the CLB population was made by counting eggs and larvae on the 19 June plant samples. In 1971, cumulative egg input (Helgesen and Haynes, 1972) was used as an insect population Index. Counts were made at 3-4 day intervals in the same 61 cm sections of row during the oviposition period in late May and early June. At each sampling, the eggs found and counted were destroyed so none remained on the plants. Counts within the survey row were totaled at the end of the oviposition season to obtain the cumulative egg input.

Since 1971 the CLB population densities have not been great enough at the test sites to obtain suitable data on the interaction of the CLB and plant density; therefore, a similar experiment was conducted in the greenhouse. Oats were planted and thinned in two rows, 17.8 cm apart, in soil in standard wood flats to obtain about the same plant densities as in the field tests. One flat of each seeding density was randomly positioned in each of four screened oviposition cages. Each cage was held in a greenhouse with conditions similar to those described by Schillinger (1969). When the seedlings were in the early two-leaf stage, ca. 15 cm high, 100 field-collected spring adult CLB were introduced into each cage. Egg counts/30.5 cm of row were made 72 hours later.

RESULTS AND DISCUSSION

Figure 1 and Table 1 show that CLB counts per unit area were directly related to the number of oat stems per unit area when CLB populations were high, as in 1971. Also, there was an inverse relationship between oat stems per unit area and CLB counts per stem, but this relationship was only clearly evident in the greenhouse test (egg counts) and to a lesser extent in the 1970 Kellogg test (egg and larval counts) (Table 2). When populations were much lower (30 eggs/61 cm of row in tests not reported here), linear relationships between stem density and CLB eggs per unit area or eggs per stem were not evident.

Several environmental factors need to be considered to interpret the data obtained in this study. For example, the CLB adult developmental temperature threshold is 9.9°C (Gage, 1972), while that of oats is between 3.3°C and 4.4°C (Coffman, 1923; Wiggans, 1956). Thus, in cool growing seasons, oat plants in thinly seeded fields may compensate by producing tillers so that by peak beetle activity, differences in tiller numbers between plots planted at different seeding rates will be minor. But because of wet soil conditions in the spring, the Michigan oat crop is often planted late enough so that peak beetle activity occurs in the early seedling stage. When this occurs, our hypothesis is that there will be greater beetle pressure per plant accompanied by reduced grain yield and quality.

Unfortunately, our insect and grain yield data from more recent unpublished tests (which included plots seeded at the recommended planting rates) have not been suitable to test the interaction of the beetle with the grain because of low populations. Several years of yield data including the effect on panicles per unit area, 1000 kernel weight, kernels per panicle, and leaf feeding damage are needed to completely understand the relationship of planting rates and the CLB. Until more yield data can be obtained, we believe that planting oats at less than recommended rates, while economically feasible in some parts of the country, is not a sound practice in CLB-infested areas.

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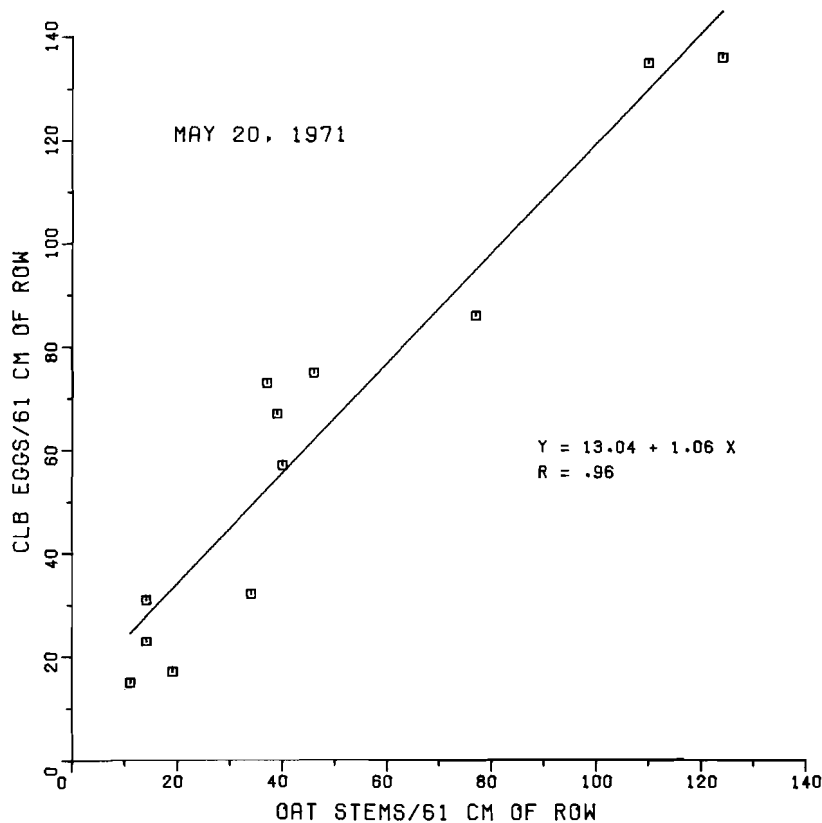
Fig. 1. Relationship between oat stems per unit area and CLB eggs per unit area when seedling oats were infested with dense populations of spring adult CLBs.

Table,1. Cereal leaf beetle counts per unit area on Clintland 64 oats seeded at three rates. 1970, n = 9; 1971, 1975, n = 4.

Year and location[b]	CLB counts ± SE[a] on oats seeded at indicated rates			LSD$_{0.05}$[c]
	Lowest	Intermediate	Highest	
1970-K	19.4 ± 2.6	45.2 ± 5.7	47.1 ± 4.6	18.8
I	8.1 ± 1.7	23.2 ± 4.1	28.3 ± 3.5	ns
1971-K	62.0 ± 9.2	139.8 ± 8.4	231.7 ± 24.8	39.7
1975-G	50.9 ± 7.3	74.8 ± 6.8	130.9 ± 4.5	13.9

[a]1970: Combined egg and larval counts from 61 cm of row on 19 June. 1971: Cumulative eggs per 61 cm of row during the oviposition period. 1975: Cumulative eggs per 30.5 cm of row 3 days after infestation.
[b]K = Kalamazoo County, MI; I = Ingham County, MI; G = greenhouse.
[c]For mean separation horizontally; ns = horizontal means not significantly different.

Table 2. Cereal leaf beetle counts per oat stem on Clintland 64 oats seeded at three rates. The stem density for the corresponding date is shown in parentheses[a]. 1970, n = 9; 1971, n = 4.

| Year location and date[c] | CLB counts/stem ± SE[b] on oats seeded at indicated rates | | | |
	Lowest	Intermediate	Highest	LSD$_{0.05}$[d]
1970-K				
19 June	0.8 ± 0.1	1.1 ± 0.1	0.5 ± 0.1	0.4
	(21.7 ± 1.8)	(41.3 ± 3.9)	(97.9 ± 7.4)	(34.4)
1970-I	0.5 ± 0.1	0.5 ± 0.1	0.4 ± 0.1	ns
	(15.7 ± 1.7)	(49.8 ± 5.7)	(78.4 ± 5.8)	(22.4)
1971-K				
20 May	1.5 ± 0.3	1.6 ± 0.2	1.3 ± 0.1	ns
	(14.5 ± 1.7)	(37.5 ± 1.3)	(89.3 ± 17.5)	(32.5)
1975-G				
8 May	6.4 ± 1.3	3.7 ± 0.3	2.9 ± 0.1	2.3
	(8.0)	(20.0)	(45.0)	

[a]Stems/61 cm–field, stems/30.5 cm–greenhouse.
[b]Ratio of CLB counts per unit area to stems per unit area. Combined egg and larval counts in 1970, egg counts in 1971 and 1975.
[c]K = Kalamazoo County, MI; I = Ingham County, MI; G = greenhouse.
[d]For mean separation horizontally; ns = horizontal means not significantly different.

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